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# PRIVATIZING SOCIAL SECURITY: THE ROLE OF IMPERFECT SUBSTITUTION BETWEEN LESS AND MORE EXPERIENCED WORKERS *

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**Abstract**

In this paper we use a large overlapping generations model with individuals that differ across *age* and *productivity* to assess the effect of privatizing a pay-as-you-go social security system in two model economies. The first one is the standard model pioneered by Auerbach and Kotlikoff (1987) characterized by the perfect substitutability in production of individuals with different experience levels. In the second one, individuals with different experience in the labor market are imperfect substitutes in production (Kremer and Thomson (1998)). The findings indicate that although in both economies the aggregate effects of removing social security are qualitatively similar, the standard model economy *underestimates* both the welfare losses of the individuals living at the period of the pension reform and the increase in pre-tax income inequality associated with such policy change.

**Keywords:** Social Security, overlapping generations.

**JEL Classification:** E62; H55; J11

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# 1 Introduction

Countries in Latin America have been ahead of other regions in undertaking major reform from pay-as-you-go defined-benefit pension plans to fully funded, defined-contribution pension plans. Because of the successful Chilean pension model, a notable number of Latin American countries have undertaken deep pension reform. Aiyer (1997) among others have highlighted the reform efforts in a sample of countries like Argentina, Brazil, Chile, Mexico, and Peru. One factor that has contributed to the need for reform in these countries is the insufficiency of contributions derived fron the sharp decrease in fertility rates and the high level of tax evasion. Despite these pension reforms in Latin America most of the developed countries have not yet accomplished the reform of their pay-as-you-go social security systems even when demographic projections for the next 30 years predict a substantial increase in the number of retirees over the working population. This paper contributes to this debate by arguing that the existence of imperfect substitutability in production between workers with different labor market experience changes in a quantitatively relevant way the dynamics of the income distribution measured by the Gini index and the welfare of the generations living at the time of the policy reform in a way that may limit the political support for the implementation of such reform. In particular, this paper evaluates the effects of phasing out the existing pay-as-you-go pension system in Spain although the effects identified here can also be relevant for any other economy. The analysis is performed in a large overlapping generations model with enough heterogeneity across individuals of the same generation so as to replicate both the earnings distribution and the percentage of the population affected by some key institutional features of the spanish social security system such as the existence of a maximum and minimum pensions limits. In this framework, I analyze the macroeconomic and welfare effects of phasing out the existing pay-as-you-go social security system in two model economies that differ from each other in the degree of substitution of the labor input with different experience levels and find that the standard model economy *understimates* both the welfare losses of the individuals living at the period of the pension reform and the increase in pre-tax income inequality associated with such policy change.

This paper is not new in addressing the effects of privatizing social security. Some examples close in spirit to this paper are Auerbach and Kotlikoff (1987), Miles (1999) and Broer (1999). These papers are motivated by the the potential economic effects caused by the individuals that belong to the baby-boom generation as they enter retirement. In this sense, the recent research effort on social security has mainly concentrated on the efficiency of the current pay-as-you-go pension system (e.g. Imrohoroglu et al. (1995) and Boldrin et al. (1999) ), the design of a feasible reform to a funded system (e.g. Conesa et al. (2000), Arjona (2000a) and Huang et al. (1996)) and the fiscal adjustments that prevents from privatization (De Nardi et al. (1999) and Arjona (2000b) and Montero (1999) for the Spanish economy). These studies are characterized by the perfect substitutability of workers with different levels of work experience, namely they abstract from the possible effect that a decrease in the labor supply of younger workers following a privatization of the pension system could have on the relative labor earnings of older workers at the time of the policy reform. In sharp contrast with this assumption, there are many empirical studies (e.g. Macunovich (1999), Murphy and Welch (1992), Katz and Murphy (1992), Freeman (1979), Welch (1979) and Berger (1985)) that have found that the age-earnings profile of workers appears to be significantly affected by the relative supply of workers with different years of working experience. Despite the potential implications of this interaction for a variety of macroeconomic issues, there are not many studies that have attempted to introduce these effects in macroeconomic models. Some exemptions are the seminal work of Lam (1989) that studied the effects of changes in age structure on life-cycle wage profiles in stable populations. In addition, Kremer and Thomsom (1998) have studied the implications of the imperfect substitution between young and old workers for the speed of convergence of per capita output between countries and find that the existence of imperfect substitutability creates a kind of adjustment cost in human capital because total output depends positively on each generation generation's human capital but negatively on the change in human capital between generations. And more recently, Rojas (2000) has shown that the effect of the aging of the baby-boom generation on the expected increase in the share of GDP spent on pensions is less severe in a model that accounts for cohort size effects than in one that abstracts from them.

This paper contributes to this last literature by comparing the quantitative properties of a policy reform aimed at funding the pension system in the standard model economy with perfect substitution across workers with different experience levels with a model economy where this substitutability is imperfect. Notice that with the phasing out of pensions, the social security tax rate falls in response to the eliminated public pensions and as individuals save for retirement through capital markets, the rate of return on capital falls. Both mechanims usually induce a reallocation of work effort over the life-cycle, substituting hours worked when young by hours worked when labor earnings peak. In the standard model economy this process has no effects on the relative wage rate of less and more experienced workers. However, in the model economy which allows for imperfect substitution, this reallocation process decreases the experience premium and imposes an additional cost (apart from the one caused by the removal of pension benefits) in terms of a lower life-time earnings on those agents that are in the years before retirement at the period of the policy reform. In addition, the change in the experienced premium moderates the fall in earnings inequality since the reallocation of work effort towards later ages over the lifecycle is less pronounced, and consequently the increase in pre-tax income inequality associated with the reform in public pensions is more relevant. In particular, the income Gini rises from 0.355 in the initial steady state to 0.455 and 0.438 in the model with perfect and imperfect substitution respectively.

The rest of the paper is organized as follows. Section 2 describes the model economies I investigate. Section 3 describes how the model is parameterized to be a realistic description of the Spanish economy in 1995. Section 4 presents the main results of the paper. Section 5 studies the sensitivity of the results to different modelling strategies and finally Section 6 concludes.

# 2 The Model

## 2.1 Demographics

The economy is populated by agents that live a maximum of $I$ periods. Upon arrival at the age of $I_A$ an agent starts taking decisions. Each individual is endowed with 1 unit of time that can be allocated to work or leisure up to age $I_{R-1}$. After this age agents retire. Each agent faces an age dependent probability of surviving between age $i$ and age $i+1$ at $t$ denoted by $s_{i,t}$. Then the unconditional probability of reaching age $i$ for an individual that has age $v$ at $t$ is

$$\pi_{v,t}^{i} = \prod_{j=v+1}^{i} s_{j-1,t+j-v-1} \tag{1}$$

with $\pi_{v,t}^{v} = 1$. Let $\mu_{i,t,j}$ be the share of age-i and type-j individuals over the total population at time $t$. $\phi_j$ denotes the proportion of an agent of type j in a particular age group and $\mu_{i,t}$ is the proportion of agents with age i over the total population. Consequently, $\mu_{i,t,j} = \mu_{i,t}\phi_j$. The law of motion of the age structure of the population is

$$\mu_{i+1,t+1} = \frac{s_{i,t}\mu_{i,t}}{1+n_t} \tag{2}$$

where $n_t$ is the population growth rate. Finally, the next period share of newly born agents $\mu_{1,t+1}$ is given by

$$\mu_{1,t+1} = 1 - \sum_{i=2}^{I} \mu_{i,t+1}. \tag{3}$$

## 2.2 Preferences

At each point in time agents are assumed to maximize lifetime utility. Hence the problem of the typical agent that at $t$ has age $i = v$ ($v \geq I_A$) is to choose consumption and leisure $l_{i,t,j} = 1 - h_{i,t,j}$ to solve the problem

$$Max \sum_{i=v}^{I} \beta^{i-v} \pi_{v,t}^{i} U(c_{i,t+i-v,j}, h_{i,t+i-v,j}) \tag{4}$$

subject to the following period-by-period constraint

$$a_{i+1,t+1,j} = (1 + r_t(1 - \tau_k))a_{i,t,j} + y_{i,t,j} - c_{i,t,j} \tag{5}$$

with $a_{i+1,t+1,j} \geq 0$, $a_{1,t,j} = 0$, $a_{I+1,t,j} = 0$. The discount parameter is $\beta$, and is assumed to be the same for all agents. Borrowing is not possible and agents accumulate asset holdings to smooth consumption over time. $r_t$ is the interest rate net of depreciation, $a_{i+1,t+1,j}$ denotes next period asset holdings, $y_{i,t,j}$ is labor income net of taxes plus transfers and $\tau_k$ is a proportional capital income tax. Let $e_{i,j}$ be the efficiency index, $\tau_{ss,t}$ the social security proportional tax, $\tau_l$ a proportional labor income tax and $d_{i,t,j}$ the social security benefits that are zero if $i < I_R$ and $d_{i,t}$ otherwise. Finally $w_{i,t}$ denotes real wages, that are indexed by age to account for the case of imperfect substitutability of labor of different age groups, and $B_t$ is the accidental bequest received at t. These considerations allow us to define the labor income net of taxes plus transfers as

$$y_{i,t,j} = w_{i,t}e_{i,j}h_{i,t,j}(1 - \tau_l - \tau_{ss,t}) + d_{i,t,j} + B_t. \tag{6}$$

### 2.3 Production Technology

Production in period t is given by a standard constant returns to scale production function that converts capital $K_t$ and labor $N_t$ into output. The technology $A_t$ improves over time at a constant rate because of labor augmenting technological change, $A_{t+1} = (1 + \lambda)A_t$. Hence,

$$Y_t = F(K_t, A_tN_t) = K_t^{\alpha}(A_tN_t)^{1-\alpha} \tag{7}$$

with

$$N_t = g(L_t, H_t). \tag{8}$$

where $L_t$ and $H_t$ denotes less and more experienced workers respectively and the function $g$ has continuous second derivatives and it is increasing and concave in labor inputs. Finally, firms rent labor and capital at given wages and net interest rate to maximize

$$F(K_t, A_t N_t) - (r_t + \delta)K_t - w_{l,t}L_t - w_{h,t}H_t \tag{9}$$

where $\delta$ is the depreciation rate for capital.

### 2.4 Government

The government levies a proportional social security tax on labor income $\tau_{ss,t}$ to finance a benefit $d_{i,t,j}$ per retiree. This system is assumed to be self-financed, i.e.

$$\sum_{j=1}^{J}\sum_{i=I_A}^{I_R-1} \mu_{i,t,j} w_{i,t} h_{i,t,j} e_{i,j} \tau_{ss,t} = \sum_{i=I_A}^{I_R-1}\sum_{i=I_R}^{I} \mu_{i,t,j} d_{i,t,j} \tag{10}$$

where benefits are computed applying a legal replacement rate to an average of past earnings up to a maximum pension limit. Hence in age $I_R$ benefits are given by,

$$d_{I_R,t,j} = max(P_{min}, min(P_{max}, \frac{rep}{1+\lambda} w_{av,j})) \tag{11}$$

where $\lambda$, $rep$, $w_{av}$ and $P_{max}$ are the productivity growth, the legal replacement rate, some average of past earnings and the maximum pension benefit respectively. From $I_R + 1$ to $I$ , the pension benefit is normalized by productivity growth $(1 + \lambda)$, since new pensions are greater than old ones, i.e.

$$d_{i,t,j} = \frac{d_{i-1,t,j}}{1 + \lambda}. \tag{12}$$

The government also levies a proportional tax on capital $\tau_k$ and labor $\tau_l$ income to finance per capita government consumption $G_t$ such that

$$\sum_{j=1}^{J} \sum_{i=I_A}^{I} \mu_{i,t,j}(r_t a_{i,t,j} \tau_k + w_{i,t} h_{i,t,j} e_{i,j} \tau_l) = G_t. \tag{13}$$

### 2.5 The Equilibrium

In this economy a *Competitive Equilibrium* is a list of sequences of quantities $c_{i,t,j}$, $h_{i,t,j}$, $a_{i,t,j}$, $\mu_{i,t,j}$, $d_{i,t,j}$, $L_t$, $N_t$, $K_t$, prices $w_{l,t}$, $w_{h,t}$, $r_t$, social security tax rates $\tau_{ss,t}$ and income tax rates such that, at each point in time $t$:

1) firms maximize profits setting wages and the interest rate equal to marginal products,

$$w_{l,t} = F_L(K_t, L_t, H_t) \tag{14}$$

$$w_{h,t} = F_H(K_t, L_t, H_t) \tag{15}$$

$$r_t = F_K(K_t, L_t, H_t) - \delta \tag{16}$$

2) agents maximize lifetime utility subject to the period budget constraints taking as given wages, the interest rate, taxes, social security benefits, survival probabilities, the age structure of the population and accidental bequests,

3) the age structure of the population $\{\mu_{i,t}\}$ is stationary and follows the aggregate law of motion (1), (2) and (3),

4) accidental bequests are given by

$$B_t = \frac{\sum_j \sum_i \mu_{i-1,t-1,j} a_{i,t,j}(1 - s_{i-1,t-1,j})}{(1 + n_{t-1}) \sum_j \sum_{i=I_A}^{I} \mu_{i,t,j}} \tag{17}$$

where $n_{t-1}$ is the growth rate of the population between period $t-1$ and $t$.

5) market clearing conditions for capital and each type of labor,

$$K_t = \sum_{j=1}^{J} \sum_{i=I_A}^{I} \mu_{i,t,j} a_{i,t,j} \tag{18}$$

$$H_t = \sum_{j=1}^{J} \sum_{i=I_E}^{I_R-1} \mu_{i,t,j} e_{i,t,j} h_{i,t,j} \tag{19}$$

$$L_t = \sum_{j=1}^{J} \sum_{i=I_A}^{I_{E-1}} \mu_{i,t} e_{i,t,j} h_{i,t,j} \tag{20}$$

where $I_E$ denotes the age at which an individual starts being considered as an experienced worker.

6) Finally, the budget constraint of the government is satisfied period by period.

Hence with these conditions the goods market clears every period,

$$F(K_t, L_t, H_t) + (1-\delta)K_t = K_{t+1} + G_t + \sum_{j=1}^{J} \sum_{i} \mu_{i,t,j} c_{i,t,j}. \tag{21}$$

# 3 Calibration

## 3.1 Demographic Parameters

Agents reach adulthood at 20 and live up to age 95, after which death is certain. Each model period corresponds to 5 years. The initial steady state is characterized by the stationary age structure of the population associated with the age survival probabilities and the population growth rate in 1995 of the spanish population being equal to 0.13% in anual term.

## 3.2 Preference Parameters

The period utility function is of the constant relative risk-aversion class

$$u(c, l) = \frac{(c^{\theta} l^{1-\theta})^{1-\sigma}}{1-\sigma} \tag{22}$$

where the inverse of the elasticity of substitution $\sigma$ and the share of consumption $\theta$ has been set such that the average time spent working is around 1/3 and the intertemporal elasticity of substitution is consistent with the empirical estimates reviewed in Auberbach and Kotlikoff (1987). Hence we use $\sigma = 2$ and $\theta = 0.33$. Finally, the discount rate parameter is set equal to $\beta = 0.987$ so as to reproduce a private capital-output ratio of 2.5 in the spanish economy as reported by Puch and Licandro (1997).

### 3.3 Government

In this model, the first role played by the government is to run a pay-as-you-go social security system that consists of a legal rule used to compute pension benefits as a function of past labor earnings. In particular, upon retirement an individual's pension is computed applying a replacement rate of 100% over the average of earnings of the last 8 years before retirement. The pension system in Spain also includes a maximum and a minimum pension level equal to 1.85 and 0.44 times the per-capita output in the spanish economy in 1995. Finally, the social security tax rate $\tau_{ss}$ is set endogenously to cover the pension burden so that the pension's system is self financed. Secondly, the government levies an income tax rate on capital and labor income to finance a given level of government consumption. In particular, we use a value of $\tau_k = 0.186$ and $\tau_l = 0.17$ as reported by Bosca et al. (1999). These values generate a government to output ratio of $G/Y = 13.4$ which is consistent with the average of this number from 1970 to 1994 in Spain.

### 3.4 Efficiency unit profile and Technology Parameters

#### 3.4.1 Efficiency unit profile

In order to generate enough heterogeneity across the individuals of the same generation, the age specific labor productivities are set following the procedure used by Huggett and Ventura (1999) and is as follows. First, using the European Comunity Household Panel (ECHP, 1994)

I compute an age specific profile of mean logarithmic gross hourly wages denoted by $\hat{y}_i$ for workers aged bewteen 20 and 64. Then, it is assumed that upon birth an agent faces a permanent individual shock $z$ to its log efficiency which determines its working productivity over its career. This shock is normally distributed as

$$z \sim N(0, \sigma_z^2) \tag{23}$$

and the log efficiency parameter at age 1 is $y_1 = \hat{y}_1 + z$. Then an agent's log lifetime efficiency profile evolves according to

$$y_i - \hat{y}_i = y_{i-1} - \hat{y}_{i-1}. \tag{24}$$

Finally the efficiency profile is $e_{i,j} = \exp(\hat{y}_i + z)$. For computational purposes I follow Huggett and Ventura (1998) and approximate the shock process $z$ with 21 evenly-space values between $-4\sigma_z$ and $4\sigma_z$. The probabilities are calculated by integrating the area under the normal distribution and the standard deviation of the stochastic process $\sigma_z$ is set to 0.532 so that the Gini index of the distribution of gross hourly wages of the model economy matches that of the ECHP data, being equal to 0.31.

#### 3.4.2 Technology Parameters

The capital share parameter is $\alpha = 0.375$ following the estimates of Domenech and Taguas (1995) for the Spanish economy. The productivity growth has been set to $\lambda = 1.5\%$ in annual terms which is the average growth of per-capita consumption over the period 1960-1995, and the depreciation parameter is set to match the average ratio of gross investment over output I/Y=22.5%. This yields a value of $\delta = 9\%$ in annual terms. These values are also used by Conesa et al. (2000).

A decision concerning the aggregation of the labor input across different age groups has to be made. The empirical studies of the effects of changes in the relative number of workers by age on age earnings profile have usually used the constant elasticity of substitution form and the translogarithmic form. For our purposes the CES functional form is very convenient because it has only one elasticity of substitution across workers with different levels of experience ($1/\rho$) and it is flexible enough to account for the perfect substitutability case ($\rho = 0$) and the imperfect substitutability model economy when $\rho > 0$.

An additional decision has to be made concerning the way in which individuals with different experience levels are sorted into different groups. Our approach follows the standard practice in the labor literature that usually sorts the population into two experience groups. The first includes those individuals with less than 25 years of experience, i.e. those who are between 20 and 44 years old. The second group contains those individuals with age more that 45 and that stay in the labor market until the retirement age 65. This choice is also consistent with Murphy and Welch (1992) that although considering 4 groups of ten years of experience, they find that those individuals with less than 20 years of experience are substitutes among them, although they are complements with those of more than 20 years of working experience. Given these considerations, the aggregate labor input is

$$N_t = B(\gamma L_t^{1-\rho} + (1-\gamma) H_t^{1-\rho})^{\frac{1}{1-\rho}} \tag{25}$$

where $L_t$ and $H_t$ are the labor supply in efficiency units of workers with less and more than 25 years of working experience respectively, and $B$ is a parameter that measures the efficiency of aggregate labor. The general procedure to set the values of the inverse of the elasticity of substitution $\rho$, the parameter $B$ and the share parameter $\gamma$ is as follows.

#### 3.4.3 Perfect substitutability

In this model economy, a change in the relative supply of experienced workers does not translate into changes in the relative wages on individuals by age. Consequently, this is the case where $\rho = 0$. In addition, the value that governs the overall efficiency of labor input is set to a normalized value of $B = 1$. Finally, the value of the share parameter $\gamma$ is set such that the age-profile of earnings in the model economy which consists of a product of the market wage $w_i$ and the efficiency index $e_{i,j}$ resembles the smoothed profile of earnings in the data. However, notice that since by construction the age-specific profile of efficiency units $e_{i,j}$ already captures this target, the share parameter $\gamma$ has to be set such that $\frac{w_h}{w_l} = 1$. Since the relative wage is given by

$$\frac{w_h}{w_l} = \frac{\gamma}{1-\gamma}\Big(\frac{H}{L}\Big)^{-\rho} \tag{26}$$

then, when $\rho = 0$, $\frac{w_h}{w_l} = 1$ if $\gamma = 0.5$.

#### 3.4.4 Imperfect substitutability

Murphy and Welch (1992), among others, have studied the existence of imperfect substitutability among workers with different levels of experience and education. Their estimates of the elasticities of complementarity imply values of the $\rho$ parameter between 0.5 and 2. In this paper we use $\rho = 1.2$ as our benchmark case for the case of imperfect substitution although in the sensitivity analysis I check the robustness of the results with a much lower $\rho$ parameter. Finally, the share parameter $\gamma$ is set (as before) such that $\frac{w_h}{w_l} = 1$, yielding $\gamma = 0.6311$, and the parameter that governs the overall efficiency of the labor input $B$ is set so that the *level* of wages equals the level of spot wages in the benchmark model economy with perfect substitutability between young and old workers, hence both model economies share the same features in the initial steady state. This yields $B = 0.9714$.

### 3.5 Computation Method

The computational procedure used to solve for the transitional dynamics of the model follows Auerbach and Kotlikoff (1987). Notice that since the economy undergoes a transition in which conditions change over time and economic agents are assumed to take into account future prices in determining their behavior, it is necessary to solve simultaneously for equilibrium in all transition years. In order to implement the computational procedure I assume that the final steady state is reached in 200 model periods, and I have checked that it was not binding. The main steps for solving this system of 200 equations and 200 unknowns are the following.

A) Given initial conditions $K_1$, $\{\{a_{i,t,j}\}_{i=I_A}^{I}\}_{t=1}$ and the path that follows the age structure of the population $\{\{\mu_{i,t}\}_{i=1}^{I}\}_{t=1}^{t=200}$, provide a guess for the path of the capital stock $\{K_t\}_{t=2}^{t=200}$, unintended bequests $\{B_t\}_{t=1}^{t=200}$ and the age profile of work effort $\{\{h_{i,t,j}\}_{i=I_A}^{Ir-1}\}_{t=1}^{t=200}$.

- Using $\{\{h_{i,t,j}\}_{i=I_A}^{Ir-1}\}_{t=1}^{t=200}$ compute labor input $\{L_t\}_{t=1}^{t=90}$ and $\{H_t\}_{t=1}^{t=200}$.
- Using $\{K_t\}_{t=1}^{t=200}$, $\{L_t\}_{t=1}^{t=200}$, $\{H_t\}_{t=1}^{t=200}$ and the marginal productivity conditions, com-

pute $\{r_t\}_{t=1}^{t=200}$ and wages by type $\{w_{l,t}\}$ and $\{w_{h,t}\}$.

- Using $\{\{h_{i,t,j}\}_{i=I_A}^{Ir-1}\}_{t=1}^{t=200}$, $\{w_{l,t}\}$ and $\{w_{h,t}\}$, compute pension benefits to which agents qualify $\{\{d_{i,t,j}\}_{i=I_r}^{I}\}_{t=1}^{t=200}$ and the necessary social security tax $\{\tau_{ss,t}\}_{t=1}^{t=200}$ to keep balanced the system.

- Use $\{r_t\}$, wages, transfers, and labor effort $\{\{h_{i,t,j}\}_{i=I_A}^{Ir-1}\}_{t=1}^{t=200}$ to solve the consumer problem in asset holdings $\{a_{i,t,j}\}_{t=2}^{t=200} \forall i, j$.

- Use $\{a_{i,t,j}\}_{t=2}^{t=200} \forall i, j$ to compute the implied capital stock $\{K_t\}_{t=2}^{t=200}$ by aggregating the asset holdings across ages for each $t$ and to compute the new level of bequests using (17) and use the implied age profile of consumption to compute a new guess of the age profile of work effort $\{\{h_{i,t,j}\}_{i=I_A}^{Ir-1}\}_{t=1}^{t=200}$ by means of the intratemporal marginal condition.

B) If the implied $\{K_t\}_{t=2}^{t=200}$, $\{B_t\}_{t=1}^{t=200}$ and $\{\{h_{i,t,j}\}_{I_A}^{Ir-1}\}_{t=1}^{t=200}$ are equal to the guesses of step A) the algorithm is stopped. If not, update the guess and go back to step A).

# 4 Findings

## 4.1 Aggregate Features

The initial steady state of the model economy has been calibrated to reproduce some key aggregate ratios of the spanish economy in 1995 and the distribution of wages in the population. Hence, in these model economies there is inter-generational and intra-generational heterogeneity. This particular feature is important because if I want the model economy to reproduce the share of GDP spent on pensions of the data 10%, the model economy has to be able to endogenously generate a similar percentage of the retirees affected by the minimum pension floor as in the data being this number 23% for those individuals affiliated to the *Regimen General*. In this respect, in the initial steady state of the model economy the percentage of GDP spent on pensions is 10.3% and the percentage of the population receiving the minimum pension level is 27.43% being these two numbers close to their empirical counterparts. Finally, in the model economy the percentage of pensioneers affected by the maximum pension level is 0.47% being this number slightly higher than the one in data 0.015%. On the other hand, recall the Gini index of wages was part of our calibration target being 0.311. In this respect, the initial model economy generates endogenously a Gini index of earnings (after taken into account hours worked) of 0.361 while the empirical counterpart in 1994 is 0.308. In addition, in the model economy the Gini index of wealth and pre-tax income is 0.567 and 0.355 repectively, where the definition of income includes earnings, capital income, social security benefits and transfers due to unintended bequests.

In this framework, the policy experiment is to set to zero the social security legal replacement rate which is applied to the average earnings before retirement in order to compute the pension level in the first period of retirement. Notice that the pension reform analyzed in this paper does no set to zero the pension benefits of all retirees. Instead, only those individuals who are near retirement suffer the removal of pensions benefits. In addition, since it is assumed that the government engages in a balanced budget policy each period, the fact that the government still pays for the pension benefits of old retirees after the policy reform means that the social security tax rate decreases through time in a smoothly way.

## 4.2 Aggregate Effects of Pension Reform

In general with the pension reform, agents work harder on average due to the lower distortions associated with the removal of social security taxes. This is specially true in the period of the policy reform for agents that are near retirement. For this reason, in the first period of the transition the capital-output and the interest rate slightly falls and increases respectively (see Figure 1). In addition, as agents now save for retirement through the capital markets, the capital stock increases inducing a higher wage rate and a lower market return on capital. As agents have perfect foresight, they take into account the general equilibrium effect of a falling interest rate and react by intertemporally substituting future consumption and leisure by present consumption and leisure early in life. This means that there is a reallocation in the life time distribution of labor supply. With funded pensions, young agents work less hours when young and more hours when old being this process common to both model economies. In the model economy with perfect susbtitution between less and more experienced workers, this reallocation process of labor effort has no effect on the experience premium which stays unaffected. However, if less and more experienced workers are imperfect substitutes in production, as individuals born over the transition work less when young and harder when old then the aggregate relative supply of experienced workers increases over the initial periods of the transition and in the long run. This process brings about a fall in the experience premium (see Figure 1) and partially compensates the tendency to concentrate labor supply in last periods of the working life (see Figure 2). It is also worth noting that this process also induce individuals to accumulate relatively more asset holdings over the early period of life and hence the capital stock increases and the rate of return of capital falls relatively more in the model economy with imperfect substitution (see Figure 1).

#### 4.2.1 Income Distribution Dynamics

There are a number of authors (Diamond (1996), James (1997)) that have suggested that one of the unpleasant features of privatizing social security is the increase in income inequality associated with such policy reform. One of the reasons that support this view is the strong redistributive component related to the existence of a maximum and a minimum pension floor. In the present framework, this is very likely to be the case since in the initial steady state with social security 27.43% of the retirees are receiving the minimum pension floor. In order to study whether there are quantitative differences between the behaviour of the model economy with and without perfect substitutability following the social security reform, in Figure 3 it is reported the dynamics of the Gini index (which a widely used indicator of inequality) of earnings, wealth and pre-tax income through the transition between steady states.

Firstly, notice that following the reform in social security the Gini earnings falls in the short and in the long run. The reason is that with the removal of the pay-as-you-go system, individuals tend to reallocate labor effort towards the ages when earnings peak and achieve a smoother age profile of work effort (see Figure 2). This process induces a more egalitarian earnings distribution and is commom to both model economies (the one with perfect and imperfect substitution between more an less experienced workers). However, in the model economy with imperfect substitution, this process is partially compensated by the fall in the wage premium and consequently the Gini index of earnings experiences a less relevant decrease.

In addition, the dynamics of the Gini wealth indicates that wealth inequality increases since although without social security all individuals save more than with social security, high earnings households have higher saving rates and consequently wealth inequality incresases very sharply. The key difference between model economies is that in the model economy with imperfect substitution, the fall in the experience premium brings about a smother asset allocation since the peak of earnings is less pronounced. Overall the dynamics of wealth distribution and the removal of the minimum pension floor associated with the privatization of social security increases income inequality in both model economies. In particular the income Gini rises from 0.355 in the initial steady state to 0.455 and 0.438 in the model with perfect and imperfect substitution respectively. The reason being, the less pronounced decrease in earnings inequality in the model with imperfect substitution between more and less experienced workers.

### 4.3 Winners and Losers from Pension Reform

In order to compute the welfare effects of phasing out the pension system, I follow the standard practice which consists of calculating compensating variations at birth for agents born with different ability levels and across time periods. In this sense, each generation is labelled by the year in which they become adults and start taking decisions, i.e, generation 2000 is composed by those individuals that are aged 20-24 in the year of the policy reform (2000), generation 1995 is composed by those individuals that became adults in that year and consequently are in the age bracket 25-29 in 2000, and so on. Hence, in the year of the policy reform are 15 generations of adults, 5 of them are young workers (those aged 20-44), 4 are old workers (those aged 45-64)and 6 are retirees (those aged 65-95). The compensating variation lists the negative of the percentage that consumption must be increase or decrease by each period over the lifetime of individuals so as they stay with the same utility as in the initial steady state with the pay-as-you-go system untouched. Consequently, the measure computed is positive if there is a welfare gain. The results are shown in Table 1 for all the generations living at the time of the policy reform and over.

It is worthy to describe firstly the results concerning the younger individuals born at the period of the pension reform. In general, the individuals that were unaffected by the minimum pension floor, i.e those with ability levels 10 and above are those who benefit more from the reform of social security over the transition because, since they were not receiving the minimum pension level, the change in the rate of return at which they can save through retirement is greater, and so is the welfare gain. For the generations born at the period of the policy reform and over there is not much difference between the model economy with imperfect substitution among experience levels and the standard model without it. One exception is worth noting. For the median and higher ability levels (recall that the median is ability 11 since there are 21 types) the welfare gains of privatizing pensions are slightly higher in the model with imperfect substitution (see Table 1). This is so because they enjoy higher lifetime wages associated with the higher capital stock, and they are also allowed to save for retirement through the market rate of return which is higher than the return on social security contributions, although this effect is compensated by the lower interest rate associated with the general equilibrium effect. As pointed out before, since in the model economy with imperfect susbtitution the capital stock increases relatively more following the reform of pensions, those individuals born in the transition enjoy higher lifetime wages and hence higher welfare than in the standard economy with perfect substitution. Notice that the magnitude of the welfare gain is lower for those agents (with ability levels between 1 and 9) whose pensions were below the minimum statutory level in the PAYG pension system because in the public pensions regime they enjoyed a high return on social security contributions.

The most stricking difference between the model with and without imperfect substitution among experience levels concerns the welfare effect of reforming public pensions for those generations that are alive when the policy change is implemented. The findings are the following. Recall that the pension reform analyzed in this paper leaves untouched the pensions of the existing retirees. Consequently in both model economies their welfare is virtually unaffected. However, there are important differences across model economies in the well-being of agents that are before retirement, i.e those in the age bracket 25-64.

On the one hand, in the model economy with imperfect substitution old workers (45-64) suffer a decline in the rate of return on assets and a lower market wage since the experience premium falls. Then the welfare losses of these individuals are more relevant as compared to the standard model economy. On the other hand, as we consider younger workers, they still suffer a decline in both the rate of return on savings and the future wages when old, but they start enjoying the higher wages while being unexperienced workers (in the imperefct substitutability case). Eventually, this last effect dominates the former and as we consider those generations born in the period of the policy reform and over the welfare losses turns out to be welfare gains. The key issue is that the fall in the experience premium changes the sign of the welfare effect of some generations. For instance, those individuals aged 25-29 have welfare gains in the standard model economy with perfect substitution but welfare losses in the one with imperfect substitution. To further understand the relevance of this result consider for instance the individual with the median ability of each generation living at the period of the policy reform. In the standard model economy the existing retirees are indifferent with the pension reform and consequently may well vote in favor it. This is also the case of the younger generations aged 20-29. In total we have that 8 generations would vote in favor of the reform and 7 generations that suffer welfare losses and would be against it. Hence, the standard model economy would predict that the reform should be implemented. Consider now the model economy with imperfect substitutability of workers with different experience levels. Now there is an additional generation (those individuals aged 25-29) that, in contrast to the previous case, suffers a welfare loss with the reform of pensions. Consequently, there are 7 generations in favor and 8 against the reform indicating political difficulties to adopt it.

## 5 Sensitivity Analysis

In this section I perform a set of experiments aimed at studying the role of alternative parameterizations concerning the degree of substitution between less and more experienced workers. The results are shown in Figures 4 and 5 and Table 2. The numerical findings indicate that as the degree of substitution between less and more experienced workers is lower, i.e $\rho = 2$ the reallocation of labor from young to older ages translates into a shaper fall in the experience premium in the initial periods of the transition and consequently the effects mentioned in the last section are reinforced. If on the contrary, we consider a much higher degree of substitution $\rho = 0.5$ which is closer to the case where this substitutability is perfect ($\rho = 0$), the macroeconomic effects of phasing out the pay-as-you-go pension system are quantitatively similar in both model economies. Although, interestingly the welfare consequences for those individuals aged 25-29 are still negative instead of positive as in the standard model economy, indicating that the results concerning the lack of political support for the reform of pensions still hold.

## 6 Concluding Remarks

This paper has extended the standard large overlapping generations model to allow for the interaction between changes in the relative labor supply of workers with different experience levels and the lifecycle profile of earnings. It is found that the macroeconomic and welfare effects of phasing out the current pay-as-you-go pension system depends critically on the modelling strategy concerning the complementarity between less and more experience workers. In particular, the results indicate that a model that abstracts from this complementarity *underestimates* both the increase in income inequality and the welfare losses of the agents living at the time of the implentation of such policy who are those that should vote for it. Hence the results of this paper go in the direction of explaining why the political support for this policy change has shown to be weak in most of developed countries.

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Figure 1: Aggregate Effects of Pension Reform, *:Imp. Subs,o: Per. Subs.

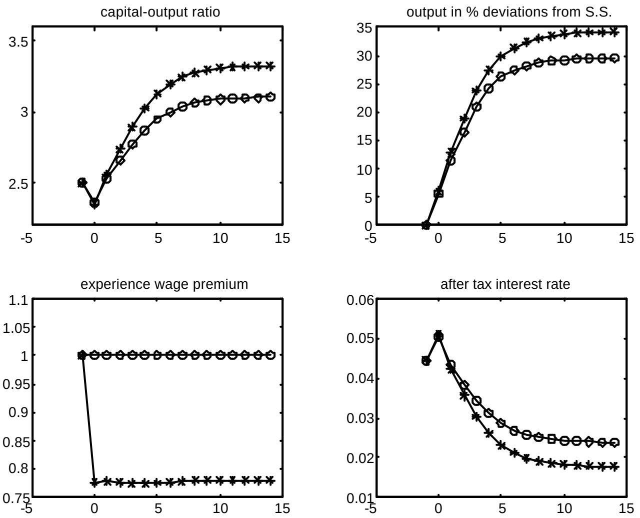


Figure 2: Median ability individuals

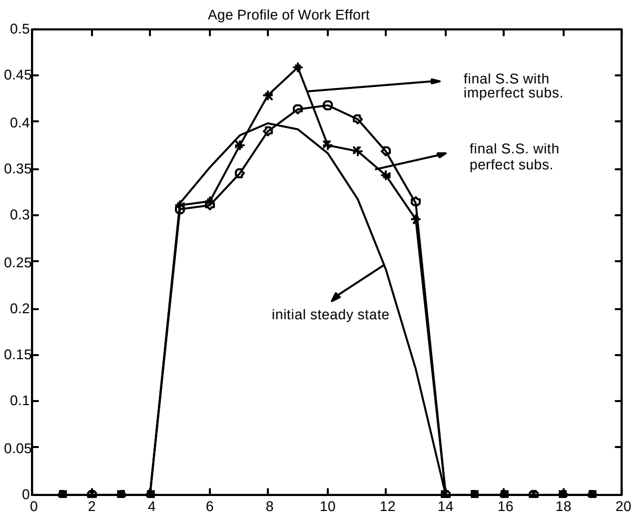

Figure 3: Distributional Statistics

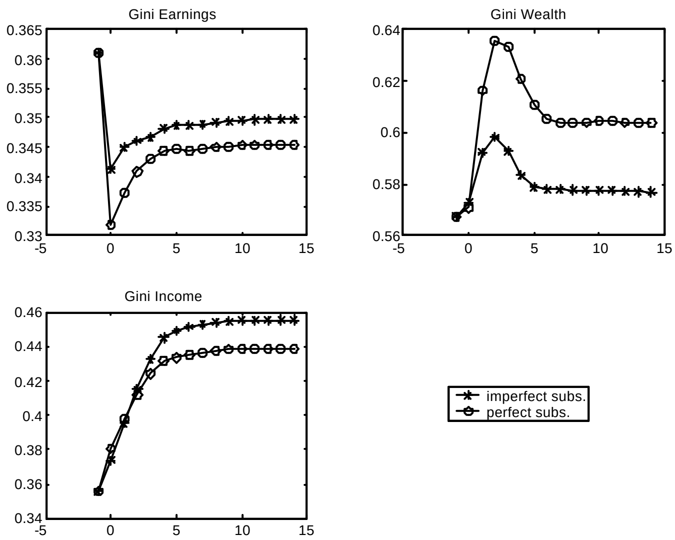


Figure 4: Sensitivity Analysis: *Low Elas., o: Per. Subs.

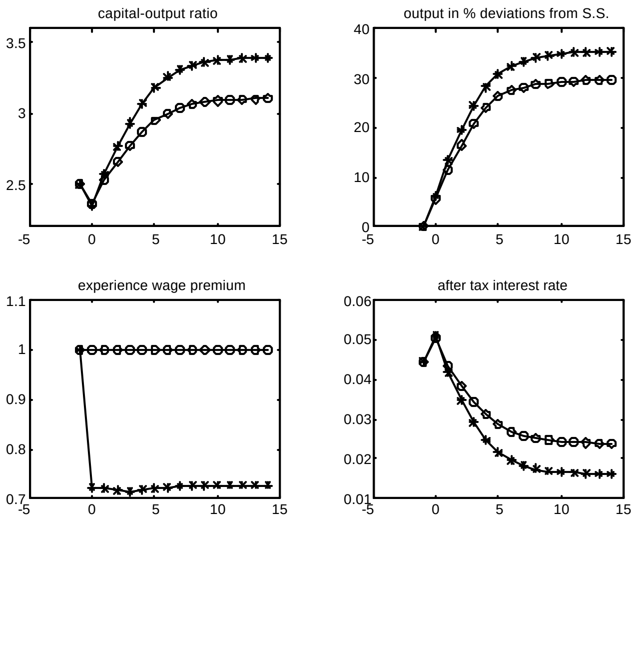

Figure 5: Sensitivity Analysis: *Low Elas., o: Per. Elas.

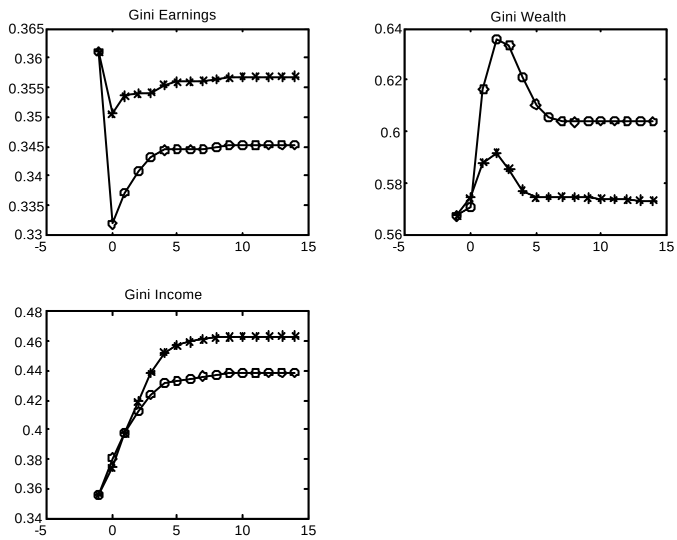

Table 1: **Welfare of Funding Pensions by cohort and type**

| Year of Birth | **Ability 3** | | **Ability 11** | | **Ability 18** | |
|---|---|---|---|---|---|---|
| | $\rho = 0$ | $\rho = 1.2$ | $\rho = 0$ | $\rho = 1.2$ | $\rho = 0$ | $\rho = 1.2$ |
| 1930 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1935 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1940 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1945 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1950 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1955 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1960 | -10.495 | -10.674 | -3.493 | -3.601 | -3.730 | -3.804 |
| 1965 | -7.582 | -7.986 | -3.062 | -3.374 | -3.262 | -3.606 |
| 1970 | -6.952 | -7.531 | -2.965 | -3.574 | -3.185 | -3.857 |
| 1975 | -6.528 | -7.398 | -2.868 | -3.939 | -3.124 | -4.279 |
| 1980 | -6.040 | -7.296 | -2.616 | -4.255 | -2.913 | -4.661 |
| 1985 | -5.345 | -6.530 | -2.096 | -3.616 | -2.439 | -4.039 |
| 1990 | -4.318 | -5.436 | -1.217 | -2.587 | -1.613 | -3.040 |
| 1995 | -2.882 | -3.858 | 0.098 | -1.048 | -0.363 | -1.546 |
| 2000 (Reform) | -1.469 | -2.067 | 1.500 | 0.863 | 0.990 | 0.339 |
| 2005 | 0.002 | -0.275 | 2.805 | 2.751 | 2.252 | 2.222 |
| 2010 | 1.633 | 1.355 | 4.115 | 4.200 | 3.488 | 3.618 |
| 2015 | 2.885 | 2.602 | 5.043 | 5.232 | 4.340 | 4.595 |
| 2020 | 3.886 | 3.557 | 5.696 | 5.946 | 4.918 | 5.253 |
| 2025 | 4.626 | 4.234 | 6.128 | 6.403 | 5.282 | 5.661 |
| 2030 | 5.075 | 4.636 | 6.383 | 6.668 | 5.495 | 5.896 |
| 2035 | 5.314 | 4.868 | 6.535 | 6.828 | 5.628 | 6.040 |
| new S.S. | 5.651 | 5.297 | 6.790 | 7.111 | 5.863 | 6.291 |

Table 2: **Sensitivity Analysis: Welfare by cohort and type**

| Year of Birth | **Ability 3** | | **Ability 11** | | **Ability 18** | |
|---|---|---|---|---|---|---|
| | $\rho = 0.5$ | $\rho = 2$ | $\rho = 0.5$ | $\rho = 2$ | $\rho = 0.5$ | $\rho = 2$ |
| 1930 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1935 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1940 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1945 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1950 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1955 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1960 | -10.590 | -10.725 | -3.546 | -3.637 | -3.750 | -3.875 |
| 1965 | -7.800 | -8.095 | -3.236 | -3.461 | -3.443 | -3.736 |
| 1970 | -7.269 | -7.680 | -3.306 | -3.749 | -3.547 | -4.082 |
| 1975 | -7.003 | -7.641 | -3.455 | -4.262 | -3.746 | -4.657 |
| 1980 | -6.722 | -7.667 | -3.505 | -4.771 | -3.851 | -5.238 |
| 1985 | -5.990 | -6.877 | -2.923 | -4.091 | -3.301 | -4.560 |
| 1990 | -4.930 | -5.750 | -1.969 | -2.998 | -2.389 | -3.490 |
| 1995 | -3.406 | -4.123 | -0.538 | -1.372 | -1.011 | -1.906 |
| 2000(Reform) | -1.757 | -2.246 | 1.159 | 0.671 | 0.652 | 0.108 |
| 2005 | -0.112 | -0.359 | 2.804 | 2.708 | 2.277 | 2.148 |
| 2010 | 1.502 | 1.282 | 4.189 | 4.196 | 3.600 | 3.587 |
| 2015 | 2.754 | 2.520 | 5.184 | 5.243 | 4.533 | 4.583 |
| 2020 | 3.734 | 3.456 | 5.883 | 5.957 | 5.169 | 5.244 |
| 2025 | 4.440 | 4.112 | 6.338 | 6.409 | 5.568 | 5.651 |
| 2030 | 4.862 | 4.503 | 6.602 | 6.672 | 5.798 | 5.886 |
| 2035 | 5.097 | 4.735 | 6.761 | 6.834 | 5.939 | 6.032 |
| new S.S. | 5.488 | 5.189 | 7.033 | 7.124 | 6.184 | 6.286 |